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LABORATORY PHOTOPLANATOR

by

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from

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ABSTRACT

LABORATORY PHOTOPLANATOR

OBJECT

Studies of body measurement as they affect physiological efficiency often require facilities for the comparative measurement of soft or easily deformable structures and also for the diametral measurement of very irregular shapes. In the case of structures of transient shape it is very desirable to have at hand a convenient means for obtaining a plurality of significant dimensions simultaneously.

RESULTS

A simple photoplanator based on the recently introduced "Enclosed-Zirconium-Arc" has been developed for laboratory and shop use. It has been used for the making and recording of quantity comparative measurements for dimensional range limit researches and also for the statistical recording of heterogeneous granular mixtures and fragmented samples.

CONCLUSIONS

For the making and recording of comparative measurements within its range of applicability photoplanation is often the easiest and most expeditious technique. The photoplanator offers many advantages in the dimensional recording of such diverse objects as meshes, air bubbles or oil droplets suspended in fluid media, egg yolks suspended in their whites, foams, and many other intangible or emollescent specimens.

RECOMMENDATIONS

None.

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LABORATORY PHOTOPLANATOR

I. INTRODUCTION

Photoplanation is not an entirely new research technique. Under various names it has been known for a long time as a versatile method of mensuration which lends itself particularly well to the measurement of easily deformable objects, to objects of very irregular shape, or to specimens exhibiting transient or variable forms. Recent developments in laboratory light sources have revived the technique and endowed it with greater precision and versatility than heretofore.

Essentially the technique of photoplanation consists in the employment of a beam of pure parallel light, substantially devoid of crossfire or abaxial rays, to cast a shadow of the object to be measured in such a fashion that the shadow will bear a dimensional relation of one-to-one to a plane projection of the object.

Such a shadow may be caused to fall on any suitable scale, grid or rule placed normal to the light beam and the shadow, of course, undergoes no change of dimension due to the act of measuring it. Usually the shadow of the object and the simultaneous shadow of a suitable transparent scale are caused to fall on a sheet of photographic paper or other photosensitive surface to obtain, by ordinary development and fixation processes, a permanent record which is suitable alike for observation, illustration, subsequent reference, or statistical compilation.

The reason that the technique has not been employed more widely heretofore has been the lack of a suitable simple light source. Outside of starlight, which is not sufficiently brilliant and is only occasionally available, the optical world has not had any convenient light source that has been substantially devoid of abaxial rays. In consequence, any apparatus for photoplanation has been very complicated optically and much too expensive for general use.

During the recent years of the war, research workers at the Western Union Company's Research Laboratories at Waterville, Long Island, New York, developed a new light source which is so small mechanically and so brilliant optically that it forms a useful source of substantially pure radial illumination and thereby lends itself to simple and comparatively inexpensive photoplanation.

This report concerns itself with the development of a laboratory photoplanator making use of the improvements in light source embodied in the Western Union Company's new arc light.

II. APPARATUS AND METHODS

A. The Zirconium Arc

This unusual light source is known as an "Enclosed Arc" or as a "Zirconium Arc", and it is commercially available in several standardized forms and sizes. It ordinarily consists of a very tiny tubular metal

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

electrode, only a few thousandths of an inch in diameter, filled with zirconium oxide and faced by an annular metal electrode, the two electrodes being sealed into a glass envelope or bulb of more or less conventional vacuum tube form. When an electric arc is struck between the two electrodes the energy of the arc heats the zirconium oxide first to fusion and then to vaporization, whereupon, a microscopic hemisphere of zirconium vapor, in a state of extreme molecular agitation, forms about the end of the tubular electrode and emits a white light of intense brilliance and substantially pure radial radiation.

A radial light source of this sort exhibits surprising properties not commonly conceived of in respect to a simple light source. For example, without accessory optical equipment such a lamp will serve as a contour projector or profile enlarger for the examination of machine tool forms and mechanical parts. Often the availability of an enclosed arc makes possible the inspection, by projection enlargement, of machined contours while the part is still in the forming machine. Or again, the lack of crossfire or abaxial radiation from these zirconium arcs makes it possible to project enlarged images of lantern slides or transparencies onto a projection screen without any associated optics.

Because of the clean radial characteristics of these zirconium arcs due to their essentially point-source dimensions, simple optical lenses function almost as well with them as highly corrected compound lenses and, hence, it requires only elementary equipment to convert their radial illumination into clean parallel beams eminently suitable for any type of photoplanation.

B. Initial Model Photoplanator

The need at this laboratory for a convenient and rapid means of measuring and comparing a large number of plastic molds of the external auditory canals of diverse human ears initiated the improvisation of a simple photoplanator consisting of a zirconium arc, a hand magnifying glass, a mount for the ear molds, and a transparent scale associated with a holder for sheets of photographic paper, all mounted on an ordinary laboratory ring stand.

This elementary photoplanator has been briefly described previously* but is here shown again in Figure 1. At the top of the ring stand is the zirconium arc, a ten-watt lamp having a source diameter of about .005 inch. This lamp is started and maintained by an electrical ballast and striking equipment shown in the case beside the ring stand. To start the arc it is only necessary to turn on the power switch and after a short interval press the temporary contact button until the arc strikes.

* J. H. St. John, Capt., M.C. Plastic Ear Mold for Communications Equipment. MDFRL Project No. 57-5, 30 September 1947

Just below the arc is a photographic shutter to interrupt the light beam and to measure off exposure periods proportioned to whatever photographic paper or other photosensitive material is being used. For most purposes an extreme contrast glossy paper is the best. Below the shutter a black paper tube prevents illumination from falling outside the magnifying lens which may be seen clamped enough lower than the arc so that the latter is at the principal focus of the lens.

Fastened to the base of the ring stand is a hinged paper holder having a circular opening cut in its hinged upper cover, and across the front of this opening there is cemented a transparent centimeter scale. Across the hinge side of the opening a slide is arranged for the insertion of transparent strips bearing numbers with which to identify successive records.

Figure 2 shows two photoplanograms of ear molds recorded on this apparatus, and Figure 3 shows a compilation of typical forms from many such photoplanator records.

Rat kidneys and other deformable objects were accurately measured and compared by this method. The facility of its use led to the construction of a more substantial but similar photoplanator as a permanent piece of laboratory apparatus.

C. New Laboratory Photoplanator

This new laboratory photoplanator is shown in Figure 4. It comprises the same elements as the preceding ring stand model with the addition of a transparent table on which to lay various objects when the instrument is in the vertical position. However, in this model the various parts are rigidly fastened together so that the instrument as a whole may be carried about from place to place without being thrown out of adjustment, and also so that it may be used in either a vertical or a horizontal position. Figure 5 shows the instrument as used horizontally to record heel profiles.

The optical system in this instrument remains as elementary as in the ring stand model. Indeed, the zirconium arc is the same arc but the field lens is larger in diameter, yielding a wider paralled beam and permitting the shadowcasting of larger objects. This optical system is shown diagrammatically in Figure 6.

In this new model there is a more convenient and critical adjustment of the position of the arc so as to obtain strictly parallel rays in the beam. This is easily effected manually by first setting an approximate position of the arc by the rod clamp shown at (a) in Figure 4 and then using the draw tube and the set screw shown at (b) for finer setting.

This final setting is facilitated by a very simple check in the following manner. A piece of black paper is folded in the middle and notched across the fold, as shown in Figure 7. The paper is then cut apart along the fold and one part, which we may call the "object half",

[illegible]

[illegible]

Figure 2 shows the photograph of [illegible] apparatus, and Figure 3 shows a [illegible] with [illegible].

[illegible]

C. The Laboratory Photoelectrometer

This [illegible] is a [illegible] of [illegible]. Figure 5 shows the instrument is used [illegible].

[illegible]

[illegible]

[illegible]

is laid on the object table. The other piece, which we will call the "reference half", is laid on the shadow plane facing the shadow of the object half, as shown in Figure 8. The exact matching of the reference half with the shadow half depends upon the precise parallelism of the light beam and is both easy to observe and very critical. With this procedure the photoplanator may be checked accurately or precisely reset in less than a minute.

It should be noted that once the halves are exactly matched for length for any one position of the object half, the match will remain perfect for all positions of the object half between the condenser lens and the shadow plane. Using vernier scales the match may be achieved to any reasonable desired degree of accuracy. When the matched adjustment is once set the true size ratio holds between the shadows of all objects introduced into the beam at any transverse position. Thus, objects may be compared with each other conveniently or, as in the case of the ear molds, with any convenient transparent scales or grids.

It is a simple matter to record the shadows of the objects and comparison scales on a sheet of photographic paper placed in the paper holder at the shadow plane and exposed by means of the shutter. Since the object shadow and the scale image are both subject to the same stretching or shrinking during the development and drying of the paper they preserve a sufficiently accurate relation to each other so that results may be accumulated during work and analyzed at any convenient time subsequently.

III. CONCLUSIONS

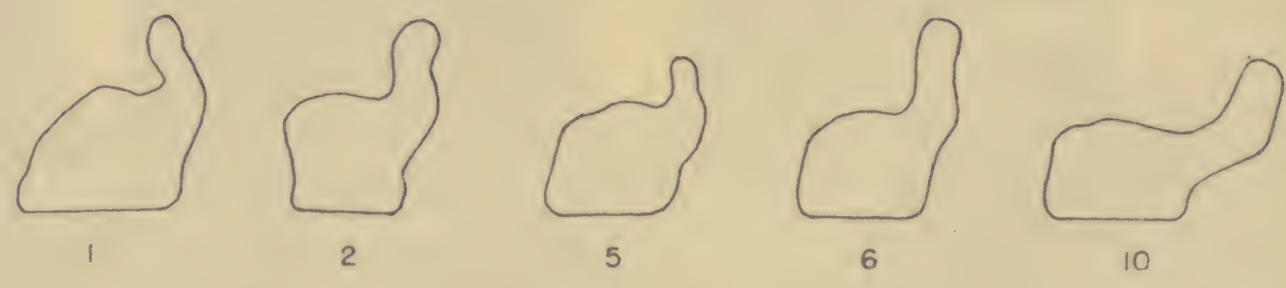
Several examples of photoplanation (Figures 9 thru 14) done on this new laboratory photoplanator are appended, including an example of template cutting for which the device is unexcelled.

It is felt that the simplicity and versatility of photoplanation with the zirconium arc is such that the general technique of photoplanation will presumably have an extended revival in research and industrial fields.

It is hoped that this brief exposition of the device may be sufficient to guide the reader toward those applications that may be of service in his sphere of endeavor.

FIG. I INITIAL MODEL PLANATOR

FIG 2. EAR MOLDS



PHOTOPLANOGRAPH TRACINGS OF REPRESENTATIVE PLASTIC EAR MOLDS

FIG. 3

FIG 4 NEW LABORATORY PHOTOPLANATOR

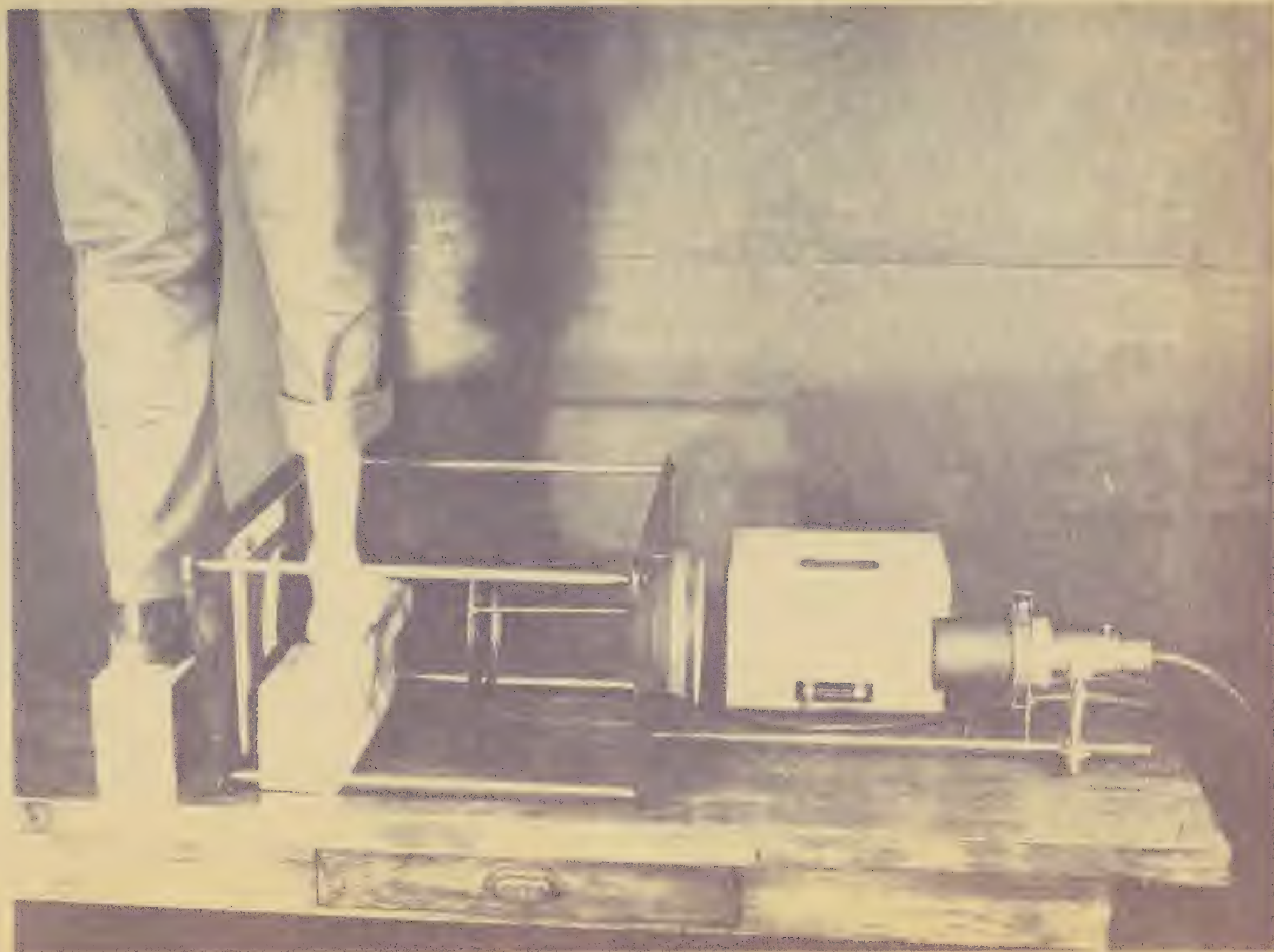
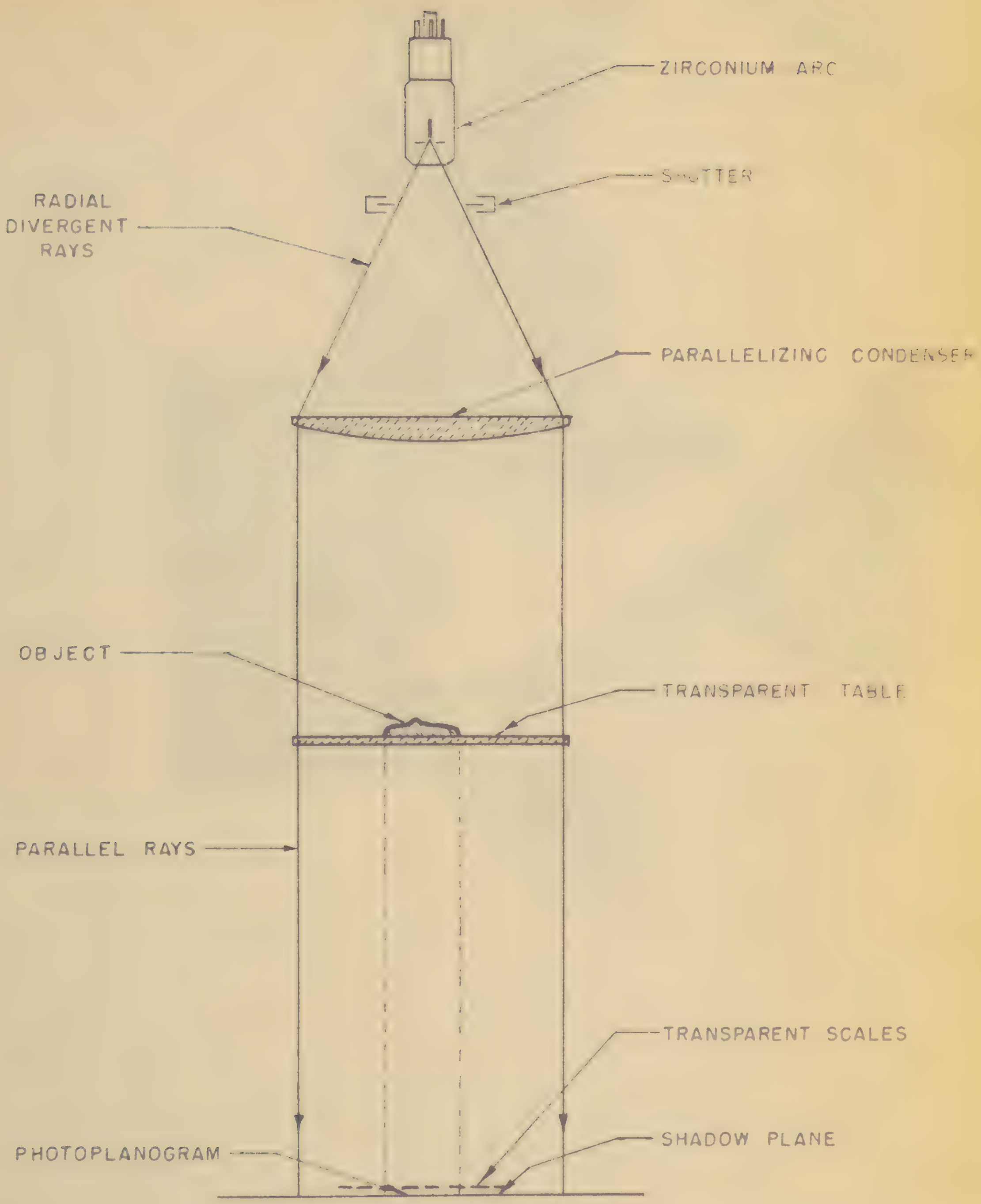


FIG. 5 LABORATORY PHOTOPLANATOR USED HORIZONTALY



PHOTOPLANATOR OPTICAL SYSTEM

FIG. 6

FIG. 7. NOTCHING FOLDED PAPER

FIG. 8. ARRANGEMENT FOR
CHECKING PARALLELISM
OF THE LIGHT BEAM.

FIG. 9 PROFILE OF HUMAN HEEL

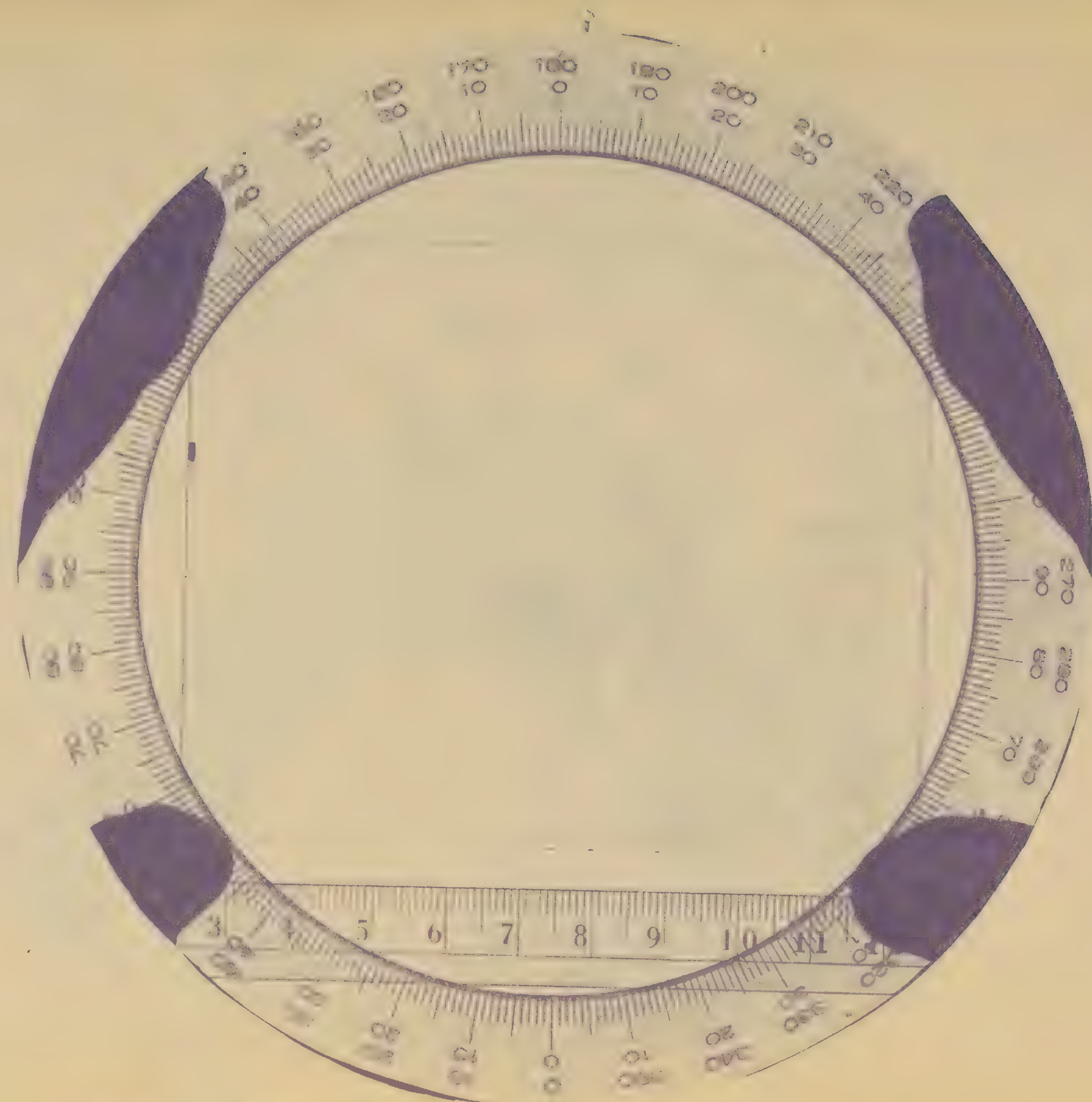


FIG. 10 TRANSPARENT FINGERPRINTS ON GLASS

FIG. 11 PHOTOPLANOGRAM FOR TEMPLATE

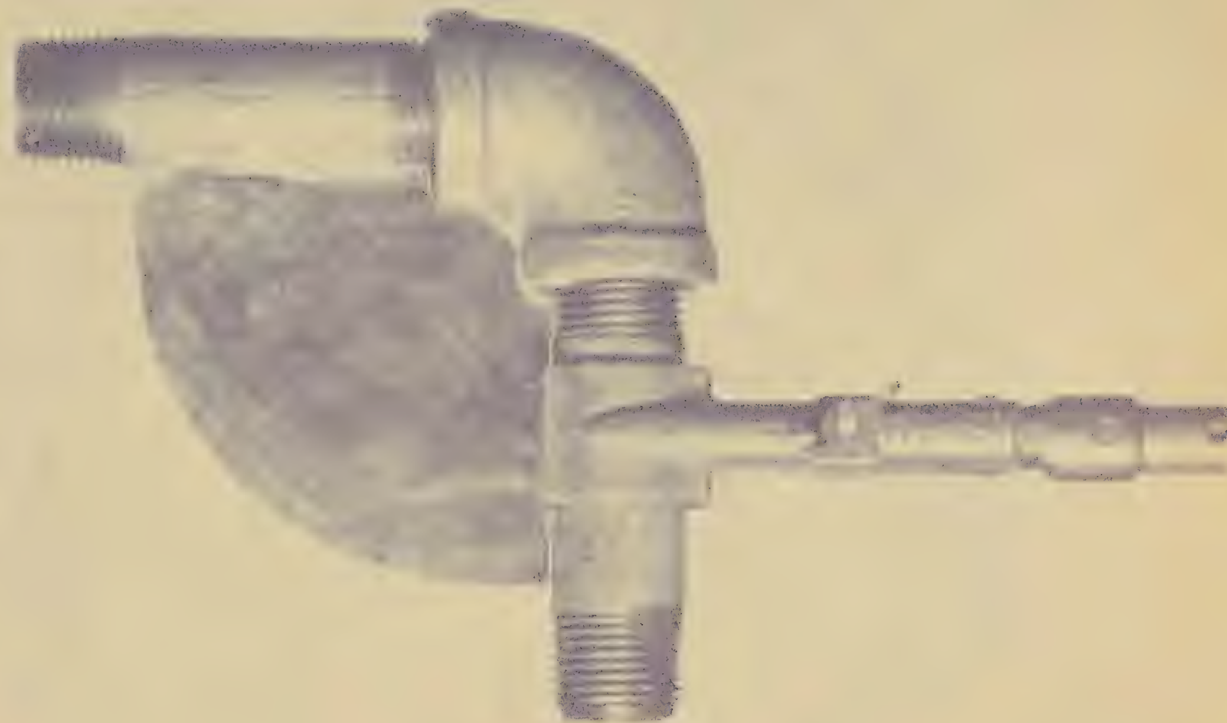


FIG. 12 TEMPLATE

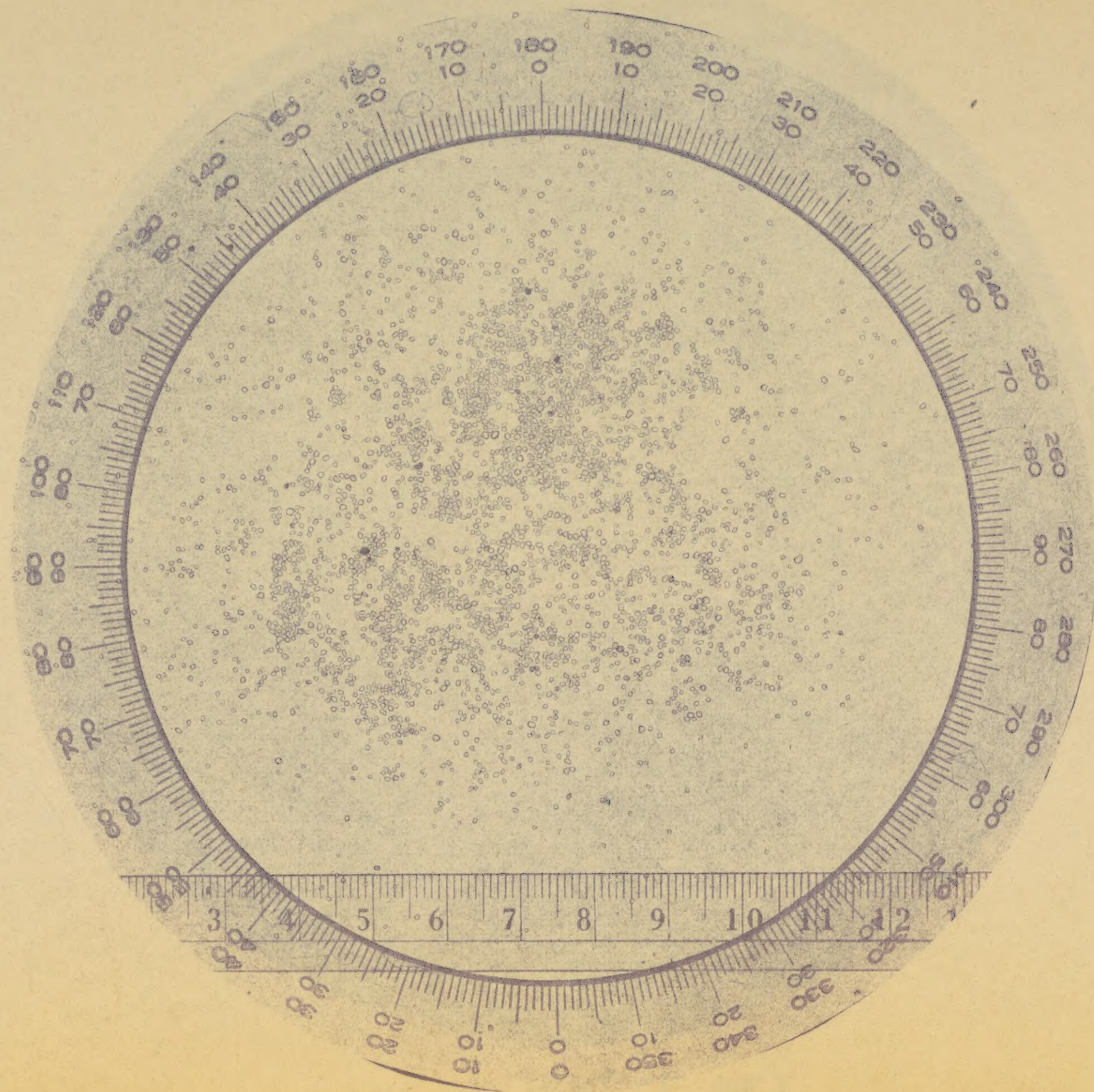


FIG. 13 SPHERICAL QUARTS GRAINS

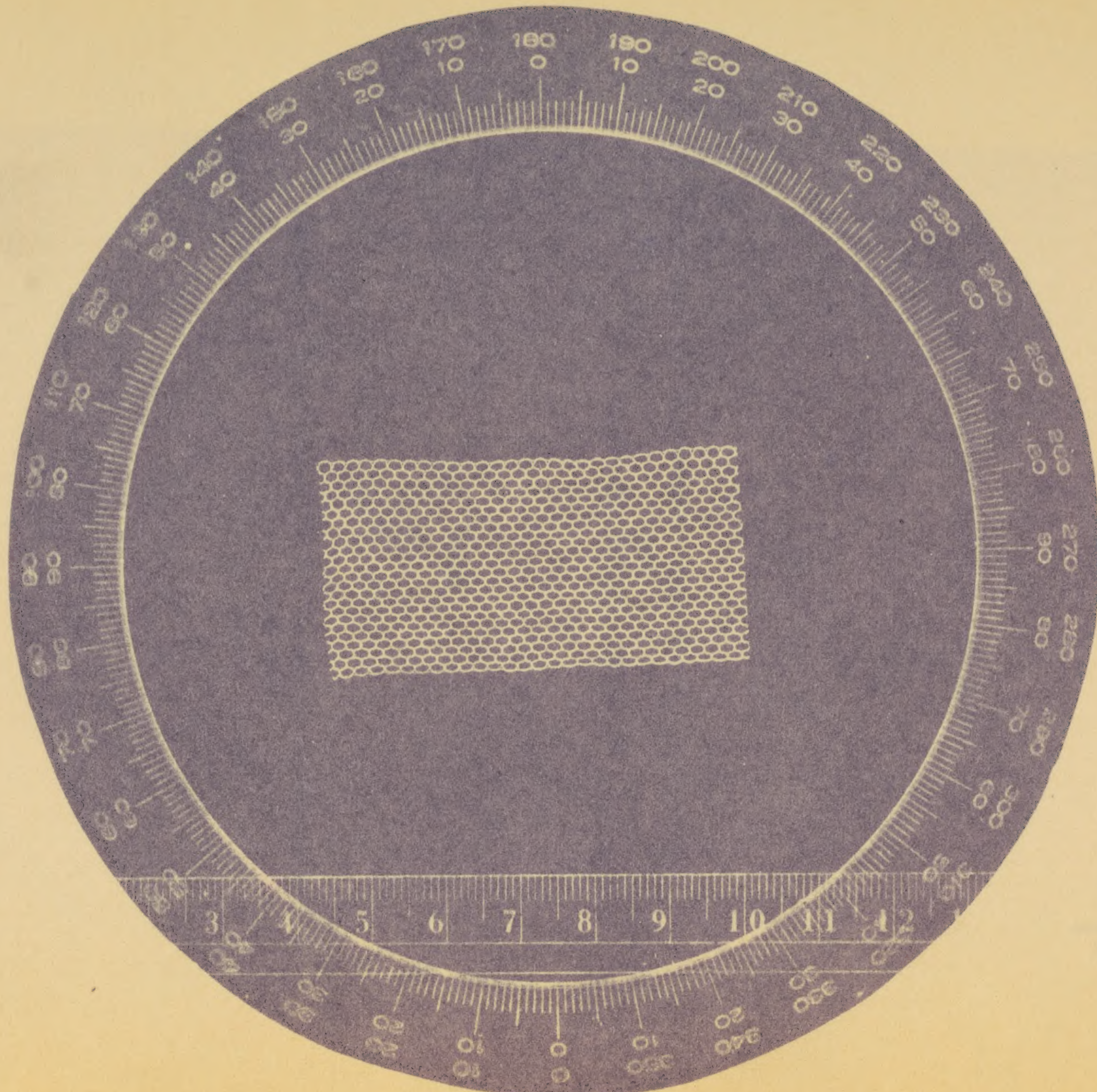


FIG 14 TEXTILE NET